Warranty

SIMPSON ELECTRIC COMPANY warrants each instrument and other articles of equipment manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any instrument or other article of equipment which shall within 90 days after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products.

This warranty shall not apply to any instrument or other article of equipment which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service stations, nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation or use not in accord with instructions furnished by the manufacturer.

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IN ENGLAND: Bach-Simpson (U.K.) Ltd., Wadebridge, Cornwall

OPERATOR'S MANUAL

SIMPSON 410
PHOTO TACHOMETER

Simpson®
INSTRUMENTS THAT STAY ACCURATE

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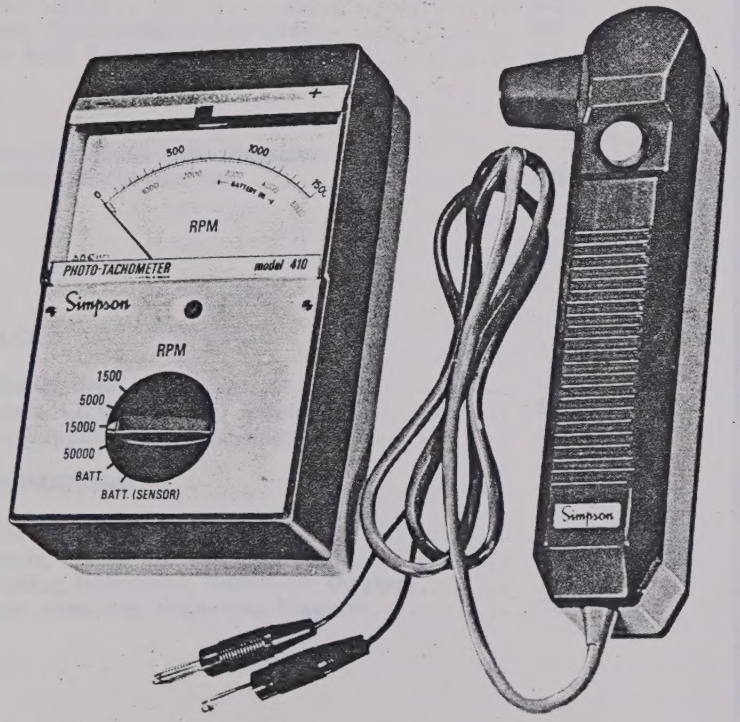

Figure 1-1. **410, Photo-Tachommeter**

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WARNING

This Instrument is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely before making any measurements. Failure to follow directions can result in a serious or fatal accident.

SHOCK HAZARD: As defined in American National Standard, C39.5, Safety Requirements for Electrical & Electronic Measuring & Controlling Instrumentation, a shock hazard shall be considered to exist at any part involving a potential in excess of 30 volts rms (sine wave) or 42.4 volts DC or peak and where a leakage current from that part to ground exceeds 0.5 milliampere, when measured with an appropriate measuring instrument defined in Section 11.6.1 of ANSI C39.5.

NOTE: The proper measuring instrument for the measurement of leakage current consists essentially of a network of a 1500 ohm non-inductive resistor shunted by a 0.15 microfarad capacitor connected between the terminals of the measuring instrument. The leakage current is that portion of the current that flows through the resistor. The Simpson Model 229-Series 2 AC Leakage Current Tester meets the ANSI C39.5 requirements for the measurement of AC leakage current and can be used for this purpose. To measure DC Leakage current, connect a 1500 ohm non-inductive resistor in series with a Simpson 0-500 DC microammeter and use this as the measuring instrument.

SECTION I

INTRODUCTION

1.1 GENERAL

1.1.1 The Simpson Model 410 Photo-Tachometer (hereafter referred to as Model 410 or simply the 410), is a modern, highly reliable portable instrument, developed to photo-electrically measure with accuracy the speed of rotating components. These components can vary from simple electrical motors to highly complicated generators, machines, and rotating devices of all kinds, up to a maximum speed of 50,000 RPM. These measurements are made photo-electrically without the Model 410 making any physical contact with the devices being measured.

1.1.2 The Model 410 Photo-Tachometer consists of an Indicating Instrument and Range Switch Assembly, and a Sensor Assembly. (See Table 7-1 for items supplied with the Instrument.)

a. The Indicating Instrument and Range Switch Assembly is designed with a six-position RPM range selector switch and an indicating dial, both located on the front panel of the Instrument. Below the dial window is a "zero" adjust screw used to adjust the meter to mechanical zero.

b. Located above the dial window are a negative (−) and a positive (+) receptacle hole used to connect the banana plugs from the pendant leads on the Sensor Assembly.

Underneath the Indicating Instrument, is an access cover provided with a captivated screw. The screw can be loosened to allow removal of the cover and thereby gain access to the battery.

c. The Sensor Assembly is designed with a movable pick-up head having 180° of rotation. The rotating head greatly adds to the Instrument's total versatility. A pushbutton switch located near the pick-up head is used to operate the Sensor Assembly. Located on the bottom side of the Sensor Assembly, is a pendant lead terminated with two banana-type connectors (black and red). These connectors are inserted in the negative (−) and positive (+) receptacle holes in the Indicating Instrument, whenever operation is desired.

d. On the opposite side of the pushbutton switch is an access cover provided with a captivated screw. The screw can be loosened to allow removal of the cover and thereby gain access to the batteries.

e. On the left side of the Sensor Assembly (looking at the pushbutton switch), is a two position switch (operate and Batt. Test), used to select operation of the Indicating Instrument, or test the battery in the Sensor Assembly (with the RPM range selector switch in the BATT. [SENSOR] position).

1.2 TECHNICAL DATA

Table 1-1 lists the Technical specifications for the Simpson Model 410 Photo-Tachometer.

Table 1-1. Technical Data

1.	DC Voltage:	
	Indicating Instrument	6.5 to 9.5 VDC (9-volt battery per NEDA 1604)
	Sensor Assembly	2 to 3 VDC (two 1.5-volt batteries per NEDA 14F)
2.	Movement:	Moving coil D'Arsonval type, magnetically shielded with a core type magnet and spring loaded jewels.
	Ranges:	Standard ranges are 0 . . . . 1500, 5000, 15000, and 50000 RPM.
	Accuracy:	Standard accuracy ±2% of full scale value on all ranges.
3.	Temperature Range:	32-68-104°F (0-20-40°C)
4.	Measuring Distance:	(3V battery voltage) NOTE: At 2V battery voltage, distances given are reduced by a maximum of 50%. Two volts is lower limit of battery test arc.
	Light Colored Marking	Distance is 0.2 to 2.0 inches with a light colored marking on a dark background, or vice versa (marking with masking tape, chalk, or paint).

	Reflective Marking	Distance is 2.0 to 12 inches with a reflective marking on a non-reflecting background or vice versa (any reflective tape or mirror).
5.	Lamp:	No. 222 lens type bulb
6.	Working Position:	Indicating instrument Horizontal Sensor assembly Unrestricted
7.	Case:	High Impact molded plastic
8.	Weight:	Instrument and sensor complete with batteries, approximately 24.7 oz. (0.7 kg)
9.	Dimensions:	
	Instrument:	3.6" high, x 6" wide x 1.8" deep (92 x 152 x 45mm)
	Sensor:	1.4" high, x 8.1" wide, x 1.9" deep (36 x 205 x 48mm)

SECTION II

CONTROLS, CONNECTORS AND INDICATORS

Table 2-1 describes all the controls, connectors and indicators of the Photo-Tachometer (see Figure 2-1). Become thoroughly familiar with each of these controls, prior to operating the Instrument for the first time.

Table 2-1. Controls, Connectors and Indicators

Indicating Instrument

1.	RPM Range Selector Switch:	The RPM range selector switch has six positions.
	BATT. (SENSOR)	Used to check the batteries in the Sensor Assembly (with the operate-Batt. Test switch in the Sensor Assembly, in the Batt. Test position and the push-button switch depressed).
	BATT.	Used to check the battery in the Indicating Instrument.
	1500, 5000 15000, 50000	These four positions are used to select the range, according to the

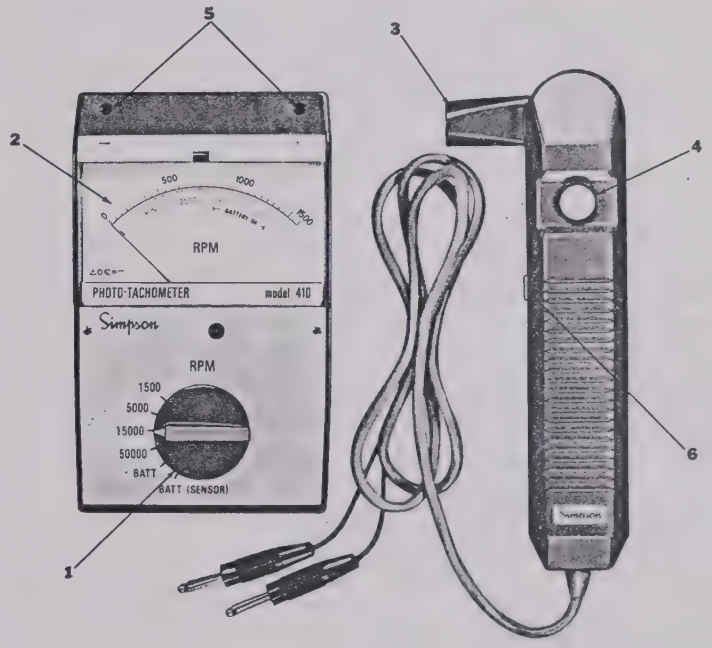

Figure 2-1. Controls, Connectors and Indicators

revolutions per minute (RPM) being tested.

2. Dial — The dial has two ranges and one scale:

Black Range — The top range (black) is calibrated from 0 to 1500, divided in increments of 50 RPM, when the range selector switch is set at 1500. When the range selector switch is set at 15000, the black range is divided in increments of 500 RPM.

Red Range — The middle range (red) is calibrated from 0 to 5000, when the range selector switch is set at 5000, the red range is divided in increments of 100 RPM. When the range selector switch is set at 50000, the red range is divided in increments of 1000 RPM.

Green Scale — The green scale is used to indicate the condition of the battery being checked. If the battery is in good condition, the indicating dial will move and stop along the green scale area.

Sensor Assembly

3. Pick-Up Head: Swivels at 180°. Picks up the signal from the rotating part being observed.

4. Pushbutton Switch:

a. When depressed, and with the Operate-Batt. Test switch in the Operate position, it applies battery power to the internal circuitry of the Sensor Assembly.

b. With the Operate-Batt. Test switch in the Operate Position, the – and + banana plugs are connected in the Indicating Instrument, and the RPM selector switch set at the desired RPM range: When the pushbutton switch is depressed the sensor assembly is energized and the Indicating Instrument monitors the RPM signal sensed by the pick-up head.

c. With the Operate-Batt. Test switch in the Batt. Test position, the – and + banana plugs connected in the Indicating Instrument, and the RPM selector switch set at the BATT. (SENSOR) position:

When the pushbutton switch is depressed, battery power from the Sensor Assembly is applied to the Sensor Assembly itself, and to the testing circuitry in the Indicating Instrument. The Indicating Instrument will thereby indicate the condition of the sensor batteries.

5. Negative and Positive Connectors: The two banana-type connectors are used for interconnection with the – and + receptacles in the Indicating Instrument.

6. Operate-Batt. Test Switch: This is a two position slide switch located on left side of Sensor Assembly (looking at the pushbutton switch).

Operate — Selects operation of the Indicating Instrument and Sensor Assembly.

Batt. Test — Selects testing of the batteries in the Sensor Assembly, with the RPM range selector switch in the BATT. (SENSOR) position, and the – and + banana plugs connected in the Indicating Instrument.

SECTION III

INSTALLATION

3.1 UNPACKING AND INSPECTION

3.1.1 Examine the shipping carton for any sign of damage. If there is none, inspect the Instruments and packing materials for obvious damage from shock, water leakage, or other causes. The Instruments should be physically free of marks or scratches and the electrical performance checked as soon as possible. If there is any indication of damage, file a complaint with the carrier immediately. Also check that all items are included.

3.2 POWER REQUIREMENTS

3.2.1 The Indicating Instrument is powered by a 9-volt battery (NEDA 1604), and the Sensor Assembly is powered by two 1.5-volt batteries (NEDA 14F).

3.2.2 The batteries are packaged separately in the carrying case. For installation instructions, refer to paragraph 6.1

3.3 INSTALLATION FOR USE

The Indicating Instrument and the Sensor Assembly can be hand held, or located on any suitable stable surface, adjacent to the equipment to be tested.

NOTE: The Indicating Instrument should always be in a horizontal position. The Sensor Assembly, however, can be in any position convenient to making a particular measurement.

3.4 APPLICATION INFORMATION

The Model 410 Photo-Tachometer can be used anywhere where there are rotating, and vibrating devices. Shaft speeds can be measured on all types of devices, from complex industrial motors to simple model airplane engines. Back and forth vibratory motion can be measured accurately. When vibration measurements are made within the operating limits of the Instrument, the results are cycles per minute rather than RPM. It is also possible to use the Model 410 as a counter, if color definition and article spacing fall within the measuring specifications. Gearbox ratios can be determined by measuring the speed of input and output shafts. The Instrument is useful anywhere, where an interrupted light level can be arranged.

SECTION IV

OPERATION

WARNING

The Simpson Model 410 Photo-Tachometer is an inherently safe device. However, while there are no hazards to the operator from the instrument itself, SERIOUS or FATAL accidents can result thru careless behavior while in the presence of rotating devices. Therefore, use extreme caution in order to prevent injury.

This section of the manual contains all the information related to operation of the Instrument. Special notes and instructions have been provided for added safety and convenience.

4.1 SAFETY PRECAUTIONS

4.1.1 The Model 410 should only be used by personnel qualified to recognize the hazards associated with rotation devices, and also shock hazards (refer to page iv), caused by electrical devices.

4.1.2 Operating personnel should be trained in safety precautions to avoid possible injury. Loose clothing or ties should not be worn near rotating machinery. When holding the Sensor Assembly near the rotating device under test, care should be exercised to prevent injury to fingers or hands.

4.1.3 Prior to use of the Model 410, each task should be thoroughly surveyed to ensure that a particular test can be

performed properly without jeopardizing the safety of the operator. The pendant cable from the Sensor Assembly should be kept away from rotating parts.

4.1.4 Measurements should be performed on exposed components only. Never perform measurements on rotating devices which are surrounded by moving belts, gears, etc., which could cause bodily injury. For example, the input and output speeds of a speed reducer can easily, and safely be measured without jeopardizing the safety of the operator. Measuring the speed of any internal component can expose the operator to injury from the moving parts, and this type of test should be avoided.

4.1.5 Should the Indicating Instrument or the Sensor Assembly be subjected to extremely high shock, the ability of the Instrument to correctly indicate RPM may be impaired.

4.1.6 Prior to use, the battery condition should be checked, both in the Indicating Instrument and the Sensor Assembly, or erroneous results may be obtained.

4.2 ZERO ADJUSTMENT

Pointer "zero" position should be checked with the Sensor Assembly disconnected. The zero position is then accomplished by turning the screw (located above the RPM range selector switch) clockwise, or counterclockwise, as necessary until the meter pointer is directly on zero.

4.3 BATTERY CHECK

4.3.1 To check the 9-volt battery in the Indicating Instrument, set the RPM range selector switch to the BATT. (SENSOR) position. The dial should come to rest on the green sector of the scale. If no indication is apparent or the pointer is out of the green scale range the battery must be replaced (refer to paragraph 6-1).

4.3.2 To check the two 1.5-volt batteries in the Sensor Assembly, connect the pendant leads of the sensor to the Instrument. Make sure to connect the – and + banana plugs according to polarity. Set the RPM range selector switch to the BATT. (SENSOR) position, and set the sensor Operate-Batt. Test slide switch to the Batt. Test position. Upon activating the pushbutton switch on the Sensor Assembly, the pointer should come to rest in the green sector on the dial. If no indication is apparent the batteries must be replaced (refer to paragraph 6-1).

4.4 SPEED MEASUREMENT

a. Connect the Sensor Assembly to the Indicating Instrument by plugging the pendant leads (– and + banana plugs) into the correct negative (–) and positive (+) receptacles.

b. Set the Operate-Batt. Test slide switch on the Sensor Assembly, to the OPERATE position and choose the required speed range by means of the RPM range selector switch, on the Indicating Instrument.

4.5 PREPARATION

4.5.1 Before applying a mark to the object to be measured, it is advisable to make a check measurement at the proposed measuring distance. If this check results in any kind of an unwanted reading, the surface shall have to be prepared to overcome irregularities which caused the readings.

4.5.2 A band of paint, or strip of adhesive tape should be applied to the surface to provide a uniform background for measurement. As an alternative, the measurement distance can be varied, until a zero response is obtained. The response ranges given in the technical specifications (Section I) should be used as a guide.

4.6 MARKING

4.6.1 The marking applied should be one which gives maximum contrast. In general, a light-dark contrast is acceptable, but for measuring distances over 2 inches, reflective tape or a mirror should be used. Reflective tape can reflect light back to the source up to an incident angle of approximately 30°, while a mirror will reflect only vertically incident light back to the source. It is important that the background surface be as uniform as possible when using reflective tape.

4.6.2 The minimum length of the marking should be 0.2 multiplied by the measuring distance. This is subject to a minimum of 0.2 inches to allow the sensor optical system to detect the mark.

4.6.3 The minimum width of the marking must be such that the pulse duration covers at least 10% of the counting

cycle. The width is therefore related to the periphery of the object such that:

Minimum marking width = 0.3 x diameter of object being measured.

4.6.4 If more than one mark is required, the width of one strip is found as above, and then divided by the number of marks required. These multiple marks must always conform to the minimum length requirement (0.2 in).

4.6.5 If the measuring distance is such, that the Model 410 ceases to indicate, or gives intermittent readings, the reflected light pulse is too weak to trigger the amplifier/threshold gate. The distance must be decreased until a positive reading is obtained.

4.7 EFFECT OF EXTRANEOUS LIGHT

Depending upon the measuring distance, intensity, modulation factor, and direction of incidence, extraneous light can give rise to incorrect readings.

4.7.1 Unmodulated light only causes errors in indication, if it falls directly upon the optical system, or if there is insufficient contrast between the object being measured and the marking applied.

4.7.2 Modulated light, such as that produced by fluorescent tubes, can cause errors in indication if the amplitude of the extraneous light is of the same order as the light pulses used for measuring purposes, or if the modulated extraneous

light falls on the instrument's optical system. To avoid these effects, it is important to screen out extraneous light effectively.

4.8 CALIBRATION CHECK

4.8.1 If light from a fluorescent lamp is available, an overall functional check of the Photo-Tachometer can be made by aiming the sensor at the fluorescent tube at a distance of about two yards.

4.8.2 The RPM range selector switch should be set to the 15000 RPM range. A speed of 7200 RPM will be indicated, since with a supply frequency of 60 Hz, the frequency of light emitted is 120 Hz; therefore, the speed indicated is 60 times the light frequency, or 7200 (RPM).

4.9 RANGE EXTENSION READINGS

When measuring low speeds, (low range and early portions of the scale) the accuracy can be increased with the use of multiple marking. Extra marks are added on the same radius on the object being measured, resulting in a higher reading which must be divided by the number of marks.

4.9.1 Every indication obtained can be checked. When making a measurement, move the sensor back and forth within the measuring distances given in the specifications. The pointer should continue to indicate the same value. Also, if a second marking is made on the same radius as the first, but offset 180°, the indicated value should be twice as high.

4.9.2 Should an additional mark be added on a different radius or track, the indicated value should remain the same.

SECTION V

THEORY OF OPERATION

5.1 INDICATING INSTRUMENT ASSEMBLY

A pulsating DC signal obtained by means of the Sensor Assembly leads is integrated and amplified. The amplified voltage is then fed to the meter movement, which gives an indication proportional to the input frequency. The push-button switch is used to connect various capacitors into the circuit, and connect the batteries so their condition can be checked.

5.2 SENSOR ASSEMBLY

The Sensor Assembly contains the light source, lens system, photo-transistor, two batteries, and associated circuitry. The light source, together with the pulse amplifier and threshold gate, is switched on by means of the pushbutton. The Instrument is ready for instant use at all times.

SECTION VI

MAINTENANCE

6.1 BATTERY INSTALLATION

6.2 Indicating Instrument. The Indicating Instrument uses one NEDA 1604 9-volt battery. Loosen the captivated screw on back of the access cover. Connect the connector to the battery and carefully install in the recessed compartment of the Indicating Instrument. Reinstall the access cover and secure in place by tightening the captivated screw.

6.3 Sensor Assembly. The Sensor Assembly uses the two "C" size 1.5-volt batteries. Loosen the captivated screw on the side opposite the pushbutton switch. Place the batteries into their compartment, making sure connection is made according to the polarity of the batteries. Reinstall the access cover and secure in place by tightening the captivated screw.

6.4 BATTERY CHECK — Indicating Instrument

Check the battery in the Indicating Instrument, in accordance with the instructions given in paragraph 4.3.1. If results are not satisfactory, replace with a standard 9-volt battery, per NEDA 1604.

6.5 BATTERY CHECK — Sensor Assembly

Check the battery in the Sensor Assembly, in accordance with

the instructions given in paragraph 4.3.2. If results are not satisfactory, replace with standard 1.5 volt "C" cells per NEDA 14F.

6.6 LIGHT BULB REPLACEMENT

After a prolonged period of usage, the light bulb may burn out. The procedure for replacement of the light bulb is the same as for replacing the Sensor Assembly batteries (refer to paragraph 6.3). Replace the light bulb with a standard No. 222 lens bulb.

SECTION VII

ORDERING INFORMATION, SCHEMATIC DIAGRAMS & AUTHORIZED SERVICE CENTERS

Table 7-1.
Items Supplied With Instrument

Qty.	Description	Part No. Cat. No.
1	Model 410 Photo-Tachometer	12604
1	Carrying Case	5-116566
2	1.5 Volt "C" Battery (NEDA 14F)	1-111801
1	9 Volt Battery (NEDA 1604)	1-110777
1	Operators Manual	5-116503
1	Lamp, 2.25 V Lens Type No. 222	5-116607

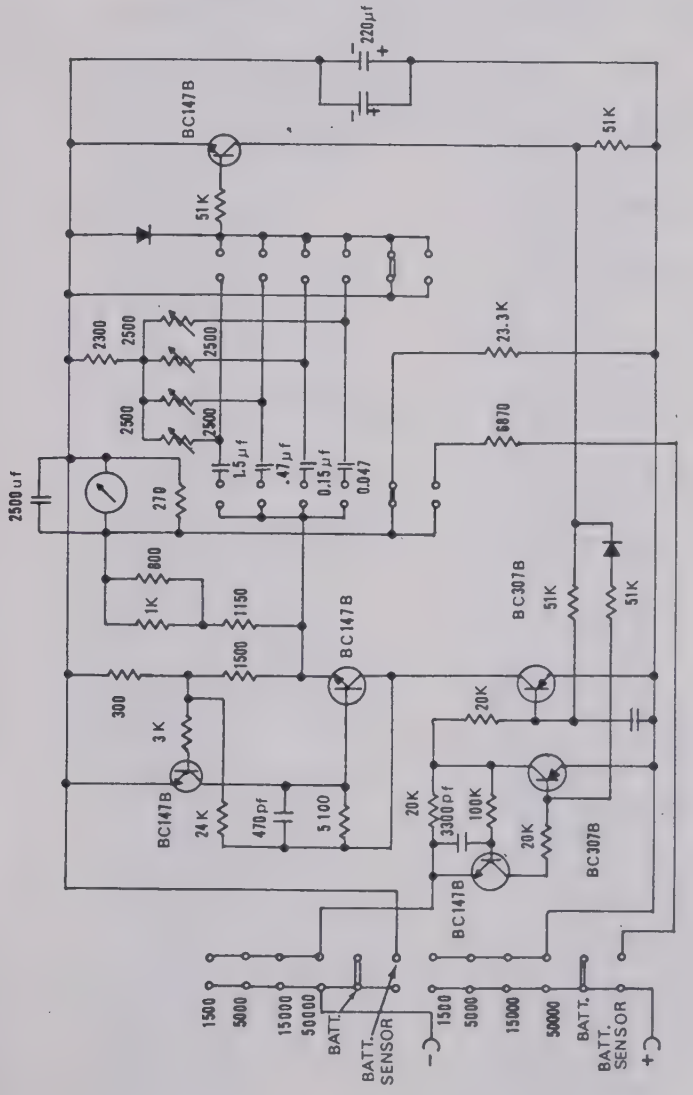

Figure 7-1. Indicating Instrument, Schematic Diagram

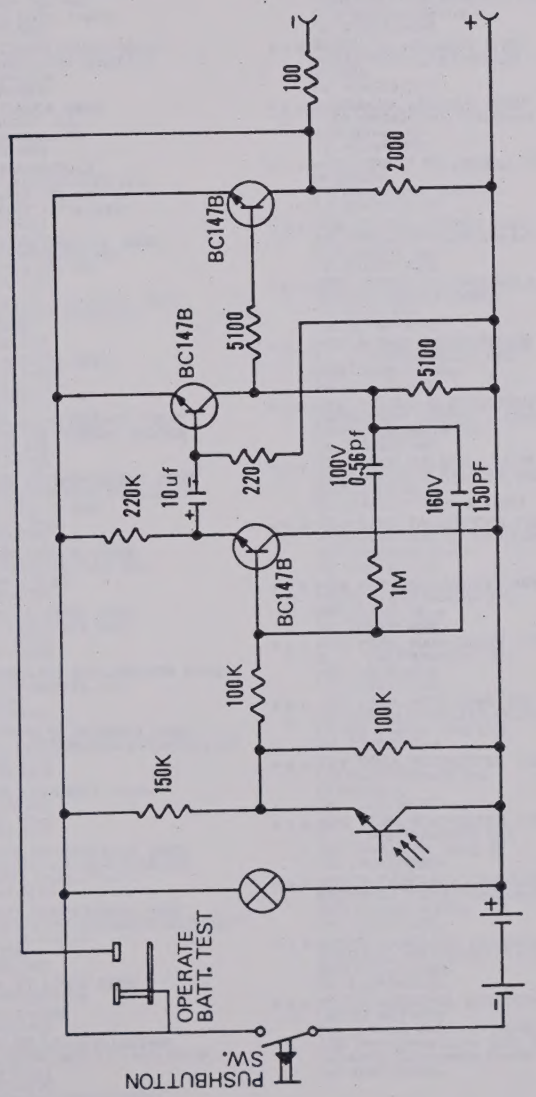

Figure 7-2. Sensor Assembly, Schematic Diagram

AUTHORIZED SERVICE CENTERS
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★★★ Full Line Digital, Analog & Control Products Equipment Sales, Parts & Repair Service Plus
□ Digital/Analog Panel Instrument & Control Product Modification Service

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Tel. 205/323-4761

★★★ **ALABAMA, MOBILE 36607**
□ ARNOLD'S INSTRUMENTS
3258 Springhill Avenue
Tel. 205/478-3230

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★★★ **ARIZONA, PHOENIX 85040**
□ METERMASTER, INC.
4134 E. Wood Street, Suite 260
Tel. 602/437-1425

★★★ **ARKANSAS, LITTLE ROCK 72209**
BROWNELL INSTRUMENTS & CONTROLS CO.
7501 I-30, Suite 15
Tel. 501/562-2061

★★★ **CALIFORNIA, DUBLIN 94566**
□ STANDARD METER LABORATORY
11815 Dublin Blvd.
Tel. 415/828-4837

★★★ **CALIFORNIA, GLENDALE 91201**
WESTERN ELECTRONIC SUPPLY CORP.
640 Allen Avenue
Tel. 818/246-4861

★★★ **CALIFORNIA, IRVINE 92714**
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17951 Sky Park Drive, Suite "F"
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★★★ **CALIFORNIA, LOS ANGELES 90040**
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6212 Peachtree Street
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Tel. 305/725-8300

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Tel. 813/885-6002

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PROCESS MEASUREMENT CO.
4509 Futon Industrial Blvd.
Tel. 404/696-7334

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□ BROWNELL INSTRUMENTS & CONTROLS C
3020 Commerce Way
Tel. 404/762-5181

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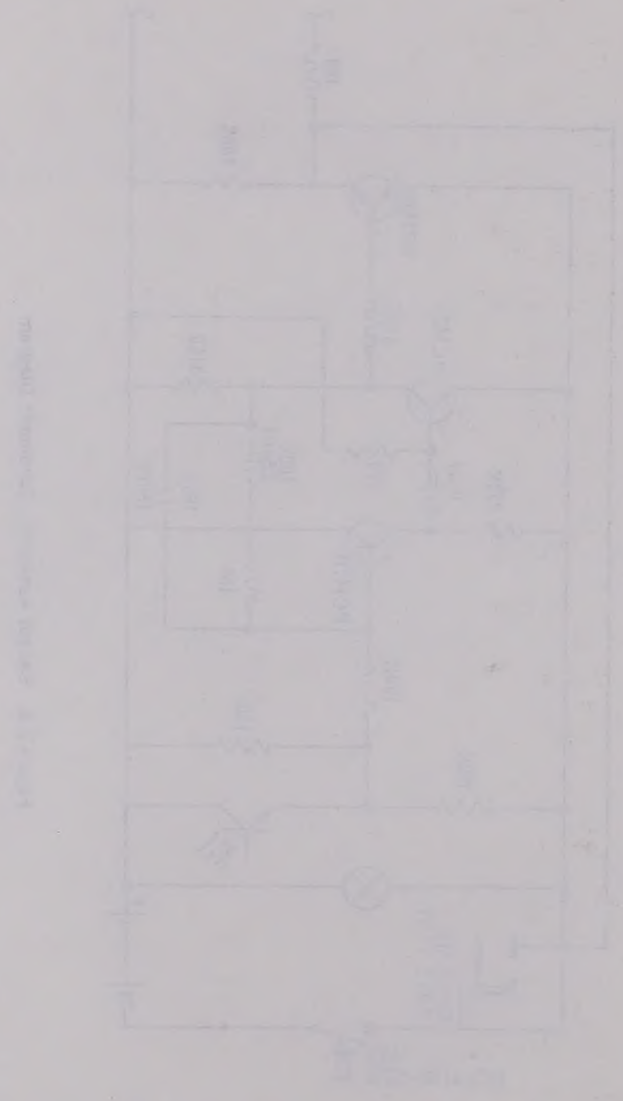
□ E. I. L. INSTRUMENTS, INC.
9708 Industrial Drive
Tel. 312/430-2292



★★★ **ILLINOIS, CHICAGO 60617**
W. H. LEARY CO., INC.
8320 Stoney Island Avenue
Tel. 312/721-3832

★★★ **ILLINOIS, COUNTRYSIDE 60525**
☐ PACIFIC INDICATOR COMPANY
5320 East Avenue
Tel. 312/352-3500

★★★ **ILLINOIS, ITASCA 60143**
☐ METERMASTER, INC.
1100 W. Thorndale Rd.
Tel. 312/250-0606

★★★ **INDIANA, EVANSVILLE**
☐ ELECTRO-LAB SERVICES INC.
1302 N. Fulton 47710 (UPS)
P. O. Box 6301 47712 (Mail)
Tel. 812/423-5211

★★★ **INDIANA, INDIANAPOLIS 46226**
☐ E. I. L. INSTRUMENTS, INC.
7061 Twin Oaks Dr. "M"
Tel. 317/545-1373

★★ **KANSAS, OVERLAND PARK 66206**
BROOKS ELECTRONICS INC.
10418 Metcalf
Tel. 913/648-3131

★★★ **KANSAS, WICHITA 67213**
☐ THE METER SHOP
1650-6 S. Meridian
Tel. 316/945-8866

★★★ **LOUISIANA, NEW ORLEANS 70123**
☐ INDUSTRIAL INSTRUMENT WORKS
5745 Salmen Ave.
Tel. 504/733-8355

★★★ **MARYLAND, GAITHERSBURG 20877**
☐ PIONEER-STANDARD ELECTRONICS
Instrumentation Division
9100 Gaither Road
Tel. 301/921-0660

★★★ **MARYLAND, SAVAGE 20863**
PYTTRONIC INDUSTRIES, INC.
8220 Wellmoor Court
Tel. 301/792-0780

★★★ **MARYLAND, SPARKS 21152**
☐ E. I. L. INSTRUMENTS, INC.
10 Loveton Circle
Tel. 301/771-4800

★★★ **MASSACHUSETTS, BURLINGTON 01803**
☐ E. I. L. INSTRUMENTS, INC.
21 "A" Street
Tel. 617/272-9450

★★★ **MASSACHUSETTS, WOBURN 01801**
BROWNELL INSTRUMENTS & CONTROL CO.
10 Linscott Road
Tel. 617/935-7820

★★★ **MICHIGAN, FERNDALE 48220**
☐ RAM METER INC.
1100 Hilton Road
Tel. 313/398-6767

★★★ **MINNESOTA, MINNEAPOLIS 55427**
☐ INSTRUMENTATION SERVICES, INC.
957 Winnetka Avenue North
Tel. 612/544-8916

★★ **MISSISSIPPI, PASCAGOULA 39567**
INSTRUMENT REPAIR SERVICE OF MISSISSIPPI
1405 Live Oak Avenue
P.O. Box 1243
Tel. 601/769-2421

★★★ **MISSOURI, ST. LOUIS 63136**
C & S INSTRUMENTS
5749 Helen Avenue
Tel. 314/383-4445

★★★ **MISSOURI, ST. LOUIS 63108-2699**
☐ I.S.L. (INDUSTRIAL SERVICE LABS) CORP.
4354 Olive Street
Tel. 314/535-5760
Outside Missouri 1-800/325-8653

★★★ **MISSOURI, ST. LOUIS 63143**
☐ SCHERRER INSTRUMENTS INC.
7170 Manchester Ave.
Tel. 314/644-5362

★★★ **MONTANA, BILLINGS 50101**
INDUSTRIAL ELECTRONICS
201 Erie
Tel. 406/259-1212

★★★ **NEBRASKA, LINCOLN 68507**
☐ ELECTROMETRICS COMPANY
6433 Havelock
Tel. 402/467-3541

★★★ **NEW JERSEY, BELLEVILLE 07109**
MISCORP
236 Washington Avenue
Tel. 201/751-1190

★★★ **NEW JERSEY, EDISON 08817**
☐ BROWNELL INSTRUMENTS & CONTROLS CO.
84 Executive Ave.
Tel. 201/287-2030

★★★ **NEW JERSEY, NEWFOUNDLAND 07435**
☐ HOSICA LABORATORIES
715 Route 23S
Tel. 201/697-7542

★★★ **NEW JERSEY, PENNSAUKEN 08109**
☐ E. I. L. INSTRUMENTS, INC.
7870 Airport Highway
Tel. 609/488-0474

★★★ **NEW MEXICO, ALBUQUERQUE 87102**
☐ INSTRUMENT SERVICE LABORATORIES
630 Haines Avenue NW
Tel. 505/842-1107

★★★ **NEW YORK, BALDWIN 11510**
☐ MEASUREMENT DEVICES, INC.
834 Merrick Road
Tel. 516/546-2777 or 546-5392

★★★ **NEW YORK, CHADWICKS 13319**
☐ UTICA/CENTRAL NY MOHAWK LTD.
3500 Bleachery Place
Tel. 315/737-7328

★★★ **NEW YORK, CLARENCE 14031**
☐ TROTT ELECTRONICS INC.
9020 Wehrle Drive
Tel. 716/634-8500

★★★ **NEW YORK, HAUPPAUGE 11787**
☐ E. I. L. INSTRUMENTS. INC.
180 Oser Avenue
Tel. 516/231-6333

★★★ **NEW YORK, NEW YORK 10011-5287**
☐ NILSSON ELECTRICAL LABORATORY, INC.
111 8th Avenue - Rm. 1525
Tel. 212/675-7944

★★★ **NEW YORK, ROCHESTER 14621**
☐ EIC ELECTRONICS INC.
85 Avenue E
Tel. 716/544-4392

★★★ **NEW YORK, ROCHESTER 14623**
☐ E. I. L. INSTRUMENTS INC.
3000 Winton Rd., Bldg. C
Tel. 716/427-8000

★★★ **NORTH CAROLINA, CHARLOTTE 28206**
☐ BROWNELL INSTRUMENTS & CONTROLS CO.
3201 Woodpark Blvd.
Tel. 704/597-1270

★★★ **NORTH CAROLINA, RALEIGH 27604**
☐ BROWNELL INSTRUMENTS & CONTROLS CO.
5245 N. Boulevard
Tel. 919/876-6524

★★★ **NORTH CAROLINA, WINSTON-SALEM 27106**
☐ METER METRICS
Div. of Fidus Instrument Corp.
4407 Providence Lane, Suite E
University Commercial Center
Tel. 919/722-1624

★★★ **OHIO, CLEVELAND 44105**
☐ PIONEER-STANDARD ELECTRONICS
Instrumentation Division
4800 East 131st Street
Tel. 216/587-3600

★★★ **OHIO, CLEVELAND 44136**
WESCHLER ELECTRIC CORP.
16900 Foltz Parkway
Tel. 216/238-2550

★★★ **OHIO, DAYTON 45459**
☐ E. I. L. INSTRUMENTS INC.
96A Westpark Drive
Tel. 513/435-2134

★★★ **OHIO, DAYTON 45424**
☐ PIONEER-STANDARD ELECTRONICS
Instrumentation Division
4433 Interpoint Blvd.
Tel. 513/236-9900

★★★ **OKLAHOMA, OKLAHOMA CITY 73107**
☐ HUSTON-DEPUE LABORATORIES INC.
536 N. Pennsylvania St.
Tel. 405/235-5469

★★ **OKLAHOMA, TULSA 74120**
AGRA ENGINEERING COMPANY
551 S. Quaker Avenue
Tel. 918/584-4235

★★★ **OREGON, PORTLAND 97217**
☐ WESTCON, INC.
5101 N. Interstate Ave.
Tel. 503/283-0132

★★★ **PENNSYLVANIA, PHILADELPHIA 19115**
☐ SUNSHINE SCIENTIFIC INSTRUMENTS INC.
1810 Grant Avenue
Tel. 215/673-5600

★★★ **PENNSYLVANIA, PITTSBURGH 15238**
☐ C.A.M. INSTRUMENTATION
620 Alpha Drive
Tel. 412/963-1885

★★★ **PENNSYLVANIA, PITTSBURGH 15221**
☐ E. I. L. INSTRUMENTS, INC.
1844 Ardmore Blvd.
Tel. 412/731-5230

★★★ **PUERTO RICO, RIO PIEDRAS 00927**
☐ B&C CALIBRATION
1113-17th St.
Villa Nevarez
Tel. 809/765-2788, 751-8375

★★★ **SOUTH CAROLINA, COLUMBIA 29210**
BROWNELL INSTRUMENTS & CONTROLS CO.
1319 St. Andrews Road
Tel. 803/772-6111

★★★ **TENNESSEE, KNOXVILLE 37922**
☐ BROWNELL INSTRUMENTS & CONTROLS CO.
207 Center Park Dr.
Tel. 615/966-3441

★★★ **TENNESSEE, MEMPHIS 38118**
☐ BROWNELL INSTRUMENTS & CONTROLS CO.
3821 Getwell Road
Tel. 901/795-8487

★★★ **TENNESSEE, MEMPHIS 38104**
☐ INSTRUMENT REPAIR SERVICE
419 N. Watkins St.
Tel. 901/278-0762

★★★ **TENNESSEE, NASHVILLE 37210**
☐ BROWNELL INSTRUMENTS & CONTROLS CO.
1837 Air Lane Drive
Tel. 615/889-8230

★★★ **TEXAS, DALLAS 75248**
☐ E. I. L. INSTRUMENTS, INC.
4392 Sunbelt Drive
Tel. 214/931-1236

★★★ **TEXAS, DALLAS 75229**
☐ ULTRA INSTRUMENT LAB., INC.
10031 Monroe, Suite 101
Tel. 214/357-0297

★★ **TEXAS, GARLAND 75041**
METERMASTER, INC.
2809 National Drive
Tel. 214/271-5671

★★★ **TEXAS, HOUSTON 77081**
☐ E. I. L. INSTRUMENTS, INC.
7385 Ashcroft Street
Tel. 713/271-3100

★★★ **TEXAS, HOUSTON 77023**
☐ METERS & INSTRUMENTS CORP.
6428 Gulf Freeway
Tel. 713/644-1631

★★★ **TEXAS, HOUSTON 77004**
☐ QUALITY INSTRUMENT LAB INC.
4832 Caroline
Tel. 713/524-0528

★★★ **TEXAS, ODESSA 79760**
☐ WHITLOCK INSTRUMENT
1306 North Texas
Tel. 915/337-3412

★★★ **UTAH, SALT LAKE CITY 84115**
METER MASTER INSTRUMENT COR
2949 South State Street
Tel. 801/486-4343

★★★ **VIRGINIA, SPRINGFIELD 22153**
☐ E. I. L. INSTRUMENTS, INC.
7643 Fullerton
Tel. 703/569-2611

★★★ **VIRGINIA, RICHMOND 23234**
☐ METER METRICS
Div. of Fidus Instrument Corp.
7400 White Pine Road
Tel. 804/275-1431

★★★ **VIRGINIA, VIRGINIA BEACH 23462**
☐ E. I. L. INSTRUMENTS, INC.
5801-A Arrowhead Dr.
Tel. 804/499-3746

★★★ **WASHINGTON, SEATTLE 98188**
☐ E. I. L. INSTRUMENTS, INC.
910 Industry Drive
Tel. 206/575-1888

★★★ **WASHINGTON, SEATTLE 98105**
☐ EICHER-RICHARDS COMPANY
2727 N. E. Blakeley Street
P.O. Box 85719
Tel. (Seattle) 206/523-7888
(Portland) 503/221-1123

★★ **WASHINGTON, SPOKANE 99220**
BLACKS-INDUSTRIAL INC.
N. 401 Helena - Box 3286
Tel. 509/534-9353

★★★ **WISCONSIN, MILWAUKEE 53202**
☐ E-M INSTRUMENTS INC.
153 No. Milwaukee Street
Tel. 414/272-7799

★★ **WYOMING, LANDER 82520**
METER SPECIALISTS, INC.
P. O. Box 595 (Mail)
Hiway 287 West (UPS)
Tel. 307/332-9711